

Remarks

This Preliminary Amendment cancels without prejudice original claims 1-12 in the underlying PCT Application No. PCT/DE2004/000603 and adds new claims 13-25. The new claims conform to U.S. Patent and Trademark Office rules and do not add new matter to the application.

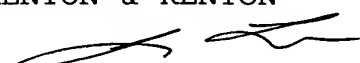
In accordance with 37 C.F.R. § 1.125(b), the Substitute Specification (including the Abstract, but without the claims) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to U.S. Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. § 1.121(b)(3)(ii) and § 1.125(c), a Marked Up Version Of The Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and entry of the Substitute Specification (including Abstract) are respectfully requested.

The underlying PCT Application No. PCT/DE2004/000603 includes an International Search Report, dated August 11, 2004. The Search Report includes a list of documents that were uncovered in the underlying PCT Application.

Applicants assert that the subject matter of the present application is new, non-obvious, and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully Submitted,

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# LOW-PRESSURE SPRAY MODULE AND METHOD FOR LOW-PRESSURE SPRAY CLEANING INCLUDING RESIDUAL CONTAMINANT ANALYSIS OF COMPONENTS

## Field of the Invention

The present invention ~~is directed~~ relates to a method for low-pressure spray cleaning and residual contaminant analysis of components using a low-pressure spray module.

## 5 Background Information

At the present time, residual cleaning and residual contaminant determination of components is performed using the dipping method including ultrasonic testing, if necessary. Using such a method, it is possible to ensure that the outer  
10 surfaces ~~in particular~~ of components are cleaned. In contrast, ~~the cleaning effect in~~ of internal areas of components, e.g., through holes or blind holes, is not ensured in every case. In some cases, wash stands are also used for cleaning, in which a cleaning medium is pumped through the component in a closed  
15 circuit at high pressures using adapters.

Accordingly, the described ~~known~~ methods for residual cleaning and residual contaminant determination of components have the ~~disadvantages~~ disadvantages that in many cases, it is not possible, or is very difficult, to clean through holes and  
20 blind holes; the cleaning modules used are usually only adapted to specific component geometries; and ~~they~~ the cleaning modules frequently require a costly filtering method due to the closed circuit of the flushing medium.

~~Object and Advantages~~

Therefore, ~~the~~an object of the present invention is to avoid the above-described disadvantages and ~~specify~~provide a method for low-pressure spray cleaning and residual contaminant analysis, as well as a low-pressure spray module, such that controlled internal cleaning of even poorly accessible areas, such as through holes and blind holes, is feasible using simple filter technology, and ~~the~~which method is compatible with various component geometries.

#### Summary

~~The core of a~~A low-pressure spray module ~~which achieves the above object is that~~provides a particle-free pressurization which is carried out without a pump, using a receiver tank which contains a flushing medium pressurized with compressed air, ~~an~~. An exchangeable spray lance having a variable diameter, shape and length ~~being~~is attached on the outlet side of the receiver tank, it being possible to couple the spray lance to a metering diaphragm valve; if nozzles are used, external cleaning of the components is also possible, and furthermore, the particle-containing flushing medium arising during the spray cleaning is collected in a collection tank in which an analysis filter is installed, which filters the particles out of the flushing medium and preserves them for later analysis.

A method for low-pressure spray cleaning and residual contaminant analysis of components, ~~operating using such as the~~above-described low-pressure spray module, includes the following steps:

- A: providing a receiver tank filled with a flushing medium;
- B: pressurizing the receiver tank on the inlet side using compressed air from a compressed air source;
- C: guiding the pressurized flushing medium from the receiver tank to a spray lance;
- D: spray cleaning the component by spraying the flushing medium from the spray lance;

E: collecting the particle-containing flushing medium in a collection tank after the spray cleaning;  
F: providing an analysis filter positioned on an outflow side of the collection tank in such a way that the particle-containing flushing medium flows through it;  
G: filtering the particles out of the flushing medium using the analysis filter, and  
H: analyzing the residual contamination filtered out by the analysis filter.

~~Preferably~~In one example, filtering out of the particles by suction of the flushing medium is supported using a vacuum pump situated at the outflow side of the collection tank downstream of the analysis filter. The residual contaminant analysis of the particles filtered out may be performed by optical microscopy or scanning electron microscopy. These features provide the following advantages of the method and the low-pressure spray module ~~of~~according to the present invention:

- controlled internal cleaning of poorly accessible areas in components, such as through holes or blind holes, by using exchangeable spray lances having matched geometry;
- variable pressure (e.g., 2 bar to 6 bar) settable or adjustable depending on the component;
- no costly filter technology due to open flushing circuit;
- filter produced specifically for cleanliness analysis to be performed using a scanning electron microscope or optical microscope;
- usable for various component geometries; and
- dead-volume-free, low particle system technology.

~~Exemplary Embodiment~~Brief Description of the Drawing

Referring to the ~~sole~~ Figure 1, ~~which shows a block diagram~~  
~~for illustrating the components essential to the present~~  
~~invention using a process flow chart, the following~~  
~~description describes~~ an exemplary embodiment of the method of  
5 the present invention for low-pressure spray cleaning and  
residual contaminant analysis, as well as a low-pressure spray  
module used for it.

#### Detailed Description

~~According to~~As shown in Figure 1, a low-pressure spray module  
10 is used according to the present invention, the main  
components of which include: a receiver tank B1 which is  
pressurized using compressed air from a compressed air source  
(line 1), the receiver tank being filled with a flushing  
medium (via a line 2), a spray lance S1 (also interchangeably  
15 called spray unit or flushing lance) connected to the outlet  
side of receiver tank B1 via a prefilter F1 and being in  
flushing medium communication with receiver tank B1 via the  
flushing medium, a collection tank B2, an inline analysis  
filter F2 which is connected to collection tank B2 via a line  
20 5 and which filters out particles from the particle-containing  
flushing medium from collection tank B2 after the component is  
washed and preserves them for later analysis, and a vacuum  
pump (not shown) connected via a line 6. All system parts are  
~~preferably~~may be made of stainless steel and are dead-volume-  
25 optimized.

Receiver tank B1 is first filled with a filtered flushing  
medium via line 2. ~~It~~The tank may be operated by connecting it  
to a compressed air system (line 1), ~~existing in the factory,~~  
as a compressed air source at a maximum pressure of  
30 approximately 6 bar. The tank pressure is controlled or  
regulated by a valve V1 located in compressed air line 1. The  
flushing medium may also be supplied to long through holes via

spray unit S1 having a lance. To ensure the necessary movability of flushing lance S1, flushing lance S1 is connected to prefilter F1 via a flexible hose 4. A second regulating/setting valve V2 is located in line 3 between prefilter F1 and receiver tank B1 for a requirements-based regulation/setting of the pressure and/or the volume of the flushing medium to prefilter F1 or to flushing lance S1. The exchangeability of spray lance S1, the diameter and length of which may vary depending on the component, and flexible line 4 make it possible to flush, i.e., spray out, components of complex design, i.e., including through holes and blind holes produced in the component from different sides.

The particle-containing flushing medium is collected in receiver tank B2 after the components are sprayed out. To that end, the upper opening of collection tank B2 advantageously widens toward the top in the shape of a funnel. The particle-containing medium collected in collection tank B2 is drawn off via inline analysis filter F2 using the vacuum pump (not shown). Immediately afterwards, it is possible to examine the ~~produced~~ filter and analyze it for the determination of residual contamination.

An undesired alternative ~~not included~~ avoided by the present invention would be to generate the pressure for the flushing medium via pumps, which would necessitate a costly filter technology for the flushing medium in order to ensure that it would have high purity. Furthermore, a high pressure drop arises, which must be accounted for in the pump power output. In contrast, an open circuit is used in the method of the present invention, in which the pressure is variable in a simple manner and no costly filter technology is needed.

The method described for low-pressure spray cleaning and residual contaminant analysis of components, and the low-

pressure spray module used for ~~it has so far been tested~~  
~~successfully~~ such method, may be used on components having  
purity-critical internal areas, ~~such as,~~ for example, high  
pressure pumps for diesel injection systems, injection  
5 nozzles, hydraulic power units for ABS systems, and other  
components of motor vehicle injection systems.

~~Abstract~~

ABSTRACT

A method for low-pressure spray cleaning and residual  
contaminant analysis of components ~~is described~~ which includes  
providing a receiver tank (B1) filled with flushing medium,  
5 pressurizing the receiver tank (B1) with compressed air on the  
inlet side, ~~conducting~~ transmitting the pressurized flushing  
medium to a spray lance (S1), spray cleaning a component by  
spraying the flushing medium from the spray lance (S1),  
collecting the particle-containing flushing medium after the  
10 spray cleaning in a collection tank (B2), providing an inline  
analysis filter (F2) positioned on an outflow side of the  
collection tank (B2) in such a way that particle-containing  
flushing medium flows through it, filtering the particles out  
of the flushing medium using the analysis filter (F2), and  
15 finally analyzing the residual contamination filtered out by  
the analysis filter. A low-pressure spray module suitable for  
use with this method is also ~~described~~ (Figure 1) provided.